The scope of the undertaking may be understood when one considers that nearly 50,000 references are brought together. These have been gathered from all sources, notably from all accessible bibliographies, serial publications and book catalogues. Finally, the effort was made to complete the lists of titles by bibliographies secured in so far as possible from authors themselves. To this end circulars were sent out to several hundred writers on ichthyology, many of whom responded cordially.

There still remain, however, a number of individual writers who have not contributed the titles of their publications. I have, accordingly, been led to publish the present note in the hope that any who have not already sent to Dr. Eastman or myself their bibliographies may be reminded that we are especially anxious to make the work as complete as possible. And we urge that their lists be sent in without delay, for the work is undergoing its final revision and the first volume is shortly to go to press. This is the "author's" volume which will consist of about 1,000 pages and include under the names of writers a serial list of their publications. The second, or "subject" volume, will be a classified index of the titles in volume I. Here one has access to special papers in the various branches, for example, in anatomy, distribution, embryology.

BASHFORD DEAN
AMERICAN MUSEUM OF NATURAL HISTORY,
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SPECIAL ARTICLES

THE ACTION OF POTASSIUM CYANIDE WHEN INTRODUCED INTO TISSUES OF A PLANT

IN an issue of SCIENCE last autumn[1] Professor Sanford mentioned some experiments conducted in California in destroying the Australian bug, *Icerya purchasi*, by the use of potassium cyanide placed in the tissues of the tree. Since that issue, a number of articles or notes have appeared from time to time discussing the possibility of the use of potassium cyanide for the destruction of various sucking and wood-boring insects, but no experimental evidence was given as to how the cyanide acted in the tree or why it should kill the insects. During the winter and spring, a few experiments were conducted along these lines. The first work was done on geraniums. A hole was made near the base of the plant and a small piece of potassium cyanide, about half the size of a pea, was placed in the stem. A split piece of rubber tubing was placed around the stem and sealed tight with paraffin to prevent leakage. Twenty-four hours later the plant was examined for the presence of cyanide. The potassium cyanide had disappeared, but the odor of cyanide was present at the wound. Sections of the stem were cut longitudinally and crosswise and tested by the Prussian blue reaction. Thick sections were placed in a 5 per cent. solution of caustic potash for about a minute, then transferred to a solution containing 2½ per cent. of ferrous sulfate and 1 per cent. of ferric chloride, heated to 60° C. After ten minutes, they were placed in a mixture of one part hydrochloric acid to six parts water. When cyanide was present, the sections showed the Prussian blue reaction in from ten to fifteen minutes.

From Mr. Sanford's article, one would expect the reaction to show in the vascular bundles or in the water-conducting tissue of the plant. Such, however, was not the case. Cyanide showed only in the outer cortical layer and in the inner pith cells, the strongest, however, in the cortical layer. The lignified tissue gave no reaction. Positive tests could be obtained for a distance of about one foot above the wound, but only about an inch or an inch and a half below the wound.

Other treated plants were allowed to continue for several days, to study the effects on the plant. It was noticed that whenever the cyanide reached the axle of a leaf, the petiole withered and died within a half-inch of the base, the leaf hanging down from the plant. Similar results were obtained whenever the cyanide reached a succulent offshoot, the cyanide seeming to blister the tissue. Tests for cyanide could not be obtained beyond the injured portion which was at the point of attachment to the stem. The reaction at that

[1] Vol. XL., No. 1032, page 519.

point, however, was stronger than on the main stem, either above or below the branch. Furthermore, it was noticed that in passing out an older lateral branch, the cyanide showed a preference for the upper side of the limb. The question arises, How does the cyanide pass through such a plant? If it passed through the vascular bundles without giving a Prussian blue test, the oxidases in that tissue would have been destroyed, but even in the stems in which a positive test could be obtained, in the cellulose tissue an oxidase test could still be obtained in the vascular bundles by both benzidine and by alpha napthol, although the reaction was not as strong as in the normal plant.

If the cyanide does not pass through the sap, one would naturally assume that it must pass up by diffusion. The facts, however, do not point to such a conclusion. Diffusion should be as rapid or almost as rapid down the stem of the plant as up the stem, which was not the case. On reaching the succulent tissue, one would expect diffusion to be more rapid, but the opposite is true. A histological examination of the tissues of the plant shows the older stems, with large intercellular spaces in the cellulose tissue, particularly in the cortical layer. The young succulent side-shoots have small or no intercellular spaces.

One might conceive of the cyanide passing up through the plant in the form of a gas. Potassium cyanide would very readily be broken up by some of the organic acids in the plant, probably carbonic acid, liberating hydrocyanic acid which could then move up between the cells of the plant without seriously injuring them, except where present in great excess. The cells would absorb some of the hydrocyanic acid, but if the amount be not too great, the cell would oxidize it by its oxidases. Granting its passage as a gas would explain its passage upward faster than downward. It would also explain why, in going out a lateral branch, it travels on the upper side rather than on the lower side and why, on reaching a succulent tissue, with small or no intercellular spaces, it is stopped in its flow. Such tissue with its greater water content would tend to dissolve the hydrocyanic in larger quantities than the cell can withstand, this resulting in the death of the tissue.

A comparative experiment was performed by introducing into the stem of the plant, by means of a siphon tube, a solution of hydrocyanic acid in distilled water. The siphon was arranged so that the pressure was just sufficient to hold the liquid against the tissue. The edges of the tube were sealed to the stem by means of paraffin. This geranium, upon examination in twenty-four hours, showed the hydrocyanic strongest in the vascular bundles rather than in the cellulose tissue. Diffusion also took place downward, as a very strong reaction for cyanide was obtained, as far as the base of the plant, eight inches below the wound. Diffusion downward, however, was stronger through the cellulose tissue than in the conducting tissue. There seemed to be no difference at the side branches—no stoppage of the hydrocyanic in its course as was found where a crystal of potassium cyanide had been introduced. The results of this experiment where the passage was by diffusion and by conduction through the vascular system was quite distinct from where the crystal of potassium cyanide had been introduced. Potassium cyanide was next tried on an apple tree during March, when the weather was still cold. At the end of two days, the limb into which the cyanide had been introduced was cut off and tested for cyanide. The test showed the cyanide only in the woody tissue; in fact, by microscopic examination, it was shown to be only in the lumen of the larger tracheæ. The distance traveled, however, was not more than two inches. Not all the KCN had disappeared from the opening, probably due to the small amount of sap in the tree and the cold weather. It was noticed that a discoloration appeared in the tissue through which the cyanide had passed. This discoloration agreed exactly with the area in which a Prussian blue reaction could be obtained. When the sap increased in the trees, further tests were made. It was found, however, that although potassium cyanide disappeared within two days, April 17–19, the hydrocyanic acid had only traveled

about a foot and a half through the woody portion of the stem. No Prussian blue reaction could be obtained in the bark or in the cambium layer, at any time. Thinking that it might be possible that the cyanide would pass rapidly through the tracheæ and later be destroyed, making a positive cyanide test impossible, a large apple tree was selected for a further experiment. Near the base a hole three quarters of an inch in diameter was bored into the wood. This was plugged up with potassium cyanide, corked and the edges of the cork sealed with collodion. A number of other holes were bored into the tree, one at a distance of a foot above the cyanide opening and four others at varying distances up the tree. These holes were about a half inch in diameter and one and one half to two inches in depth. Rubber stoppers through which were passed glass tubes, sealed at the outer end and containing distilled water, were placed in these holes and the edges sealed with collodion. These were quite comparable to the burrows of a wood-boring insect, and as hydrocyanic is very soluble in water, the water in the tube would dissolve any hydrocyanic passing into these holes. With a negative test in these tubes, the hope of destroying wood-borers extensively through the tree would vanish. The tubes were examined from day to day for the presence of cyanide. Although, by the 22d, all the cyanide had disappeared from the opening, no test could be obtained in any of the tubes, either by precipitation with silver nitrate or by the Prussian blue reaction. On April 29, the tree was examined to determine the path of the hydrocyanic acid. It was found that the hydrocyanic acid had passed through an area varying from an inch to a half inch in diameter, beginning at the upper side of the hole, next to the cork, and had traveled through the woody tissue, missing the first hole containing a tube, by about two inches, continuing up the tree to a height of about seven feet, where the test became weaker and finally negative. The highest opening in the tree, which was at a height of about six and one half feet, was missed by less than a half inch, the course of the hydrocyanic having been interrupted by a knot which it had gone around or otherwise a positive test might have been obtained in this tube.

In the other trees, it was noticed that the hydrocyanic passed through a particular area which had its point of departure on the upper side of the cyanide hole, next to the cork. If the hole drilled in the tree is at right angles to the tree, the hydrocyanic passes up evenly from the upper side of the hole but does not diffuse throughout the wood.

From these experiments, it seems that unless one could collect their wood-borers and have them located definitely in the tree, that treatment would be of little or no value. It might be locally applied where the wood-borer is definitely located, by drilling a hole just beneath it and introducing the potassium cyanide or where the borer has made a large burrow one might successfully introduce the potassium cyanide into the burrow. For the larger number of wood-borers, such as inhabit our oaks—boring in the cambium layer—this treatment would have little or no value, as the hydrocyanic does not travel in the cambium but only through the old tracheæ. For sucking insects, which feed at the vascular bundles, it does not seem that the cyanide could be successfully used. In the light of these experiments, it seems that the Spanish broom upon which Professor Sanford destroyed his Australian bugs, must have a peculiar structure to permit the cyanide to pass through an area reached by the Australian bug. If it is a semi-woody plant, similar to the geranium, it would be conceivable that hydrocyanic acid would pass through the cortical layer and be of some value. To be successful against sucking insects, it would have to pass through the vascular system where the insects feed or between the outer surface and the vascular system. The latter is possible in herbaceous or semi-woody plants but would greatly endanger the life of the plant.

In woody trees, where its path is in the older tracheæ, there seems to be no danger to the tree, as these tracheæ are already dead. Excessive amounts might prove dangerous. It is conceivable that the amount used by Professor

Sanford in his peach tree would act as a stimulant to the tree as in other work upon the effects of fumigating greenhouse plants with hydrocyanic acid evidence has been obtained of stimulation, the results of which will be published later.

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE SECTION B, PHYSICS

By combining their interests Section B of the American Association for the Advancement of Science and the American Physical Society always have exceedingly profitable joint meetings; meetings at which nearly all the progressive physicists of the States and of Canada become personally acquainted and from which they return to their respective laboratories taking with them the inspiration of new ideas and the cheer of many friendships.

The recent Philadelphia meeting, at which President Ernest Merritt of the American Physical Society and Vice-president Anthony Zeleny of the American Association for the Advancement of Science alternately presided, was typical of these delightful and helpful occasions.

The address of the retiring vice-president and chairman of Section B, Dr. A. D. Cole, was on "Recent Evidence for the Existence of the Nucleus Atom."

The structure of the atom has been and still is *the* goal of modern physical investigation. Possibly it may never be attained, but the failure to attain it should not be regretted so long as endeavors to this end continue to yield, as heretofore, such valuable incidental discoveries. Dr. Cole's address, published in full in the January 15 issue of Science, reviews a number of the more recent of these discoveries, and also gives references to many original papers. Both addresses and references will be of great assistance to every physicist who really is interested, whether actively or passively, in that baffling yet enticing subject, the structure of the atom.

The usual symposium consisted, at this meeting, of addresses on "The Use of Dimensional Equations," by Dr. Edgar Buckingham and Dr. A. C. Lunn, followed by discussions by Dr. W. S. Franklin, Dr. A. G. Webster, and others.

Dr. Buckingham's address, following somewhat his paper in the October, 1914, issue of the *Physical Review,* emphasized the practical use of dimensional equations in the logical or mathematical discussion of physical problems.

Dr. Lunn considered the mathematical and metaphysical aspects of the subject, and so interestingly that it is to be hoped that he too will publish in full his contributions to this subject.

The discussion and remarks that followed the principal papers indicated a recognition of the importance of the subject, but also a frank admission that its daily use in the laboratory and the classroom is, perhaps, rather limited.

The sectional committee nominated, and the general committee later elected, Professor Frederick Slate vice-president and chairman of Section B. Professor Slate, however, was unable to serve and a new election therefore was necessary. This was completed at the April meeting of the Council, resulting in the selection of Dr. E. P. Lewis, of the University of California.

At present the officers of Section B are as follows:

Vice-president and Chairman of the Section, E. Percival Lewis, University of California, Berkeley, Cal.

Secretary, William J. Humphreys, Weather Bureau, Washington, D. C.

Member of Council, Gordon F. Hull, Dartmouth College, Hanover, N. H.

Sectional Committee, Vice-president, Philadelphia, Anthony Zeleny; Vice-president, San Francisco and Columbus, E. Percival Lewis;

Secretary, William J. Humphreys, Weather Secretary, Alfred D. Cole; Anthony Zeleny, 1 year; T. C. Mendenhall, 2 years; Dayton C. Miller, 3 years; George W. Stewart, 4 years;